ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 163506

Proj. ECN

2. ECN Category (mark one) Supplemental ~~[X]~~ Direct Revision ~~[X]~~ Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. B. A. Higley, LMHC, H5-27, 376-5694	4. USQ Required? [] Yes [X] No	5. Date 7/29/97
	6. Project Title/No./Work Order No. Tank 241-U-107	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-614, Rev. 0	10. Related ECN No(s). NA	11. Related PO No. NA

12a. Modification Work [] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	12b. Work Package No. NA	12c. Modification Work Complete NA Design Authority/Cog. Engineer Signature & Date	12d. Restored to Original Condition (Temp. or Standby ECN only) NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change 13b. Design Baseline Document? [] Yes [X] No

Add Appendix D, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-U-107.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[X]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-U-107 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

15. Distribution (include name, MSIN, and no. of copies)

Central Files	A3-88	K. M. Hall	R2-12
DOE Reading Room	H2-53	K. M. Hodgson	R2-11
TCSRC	R1-10	J. Jo	R2-12
File	H5-49		
B. A. Higley	H5-27		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

RELEASE STAMP

DATE: STA: HANFORD RELEASE ID:

AUG 28 1997

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) 163506

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
NA		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. M. J. Kupfer	MJ Kupfer	8-27-97	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	8-27-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J. Jo	Jaiduk Jo	8-27-97	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-U-107

B. A. Higley
Lockheed Martin Hanford Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 163506 UC: 712
Org Code: 74640 Charge Code: N4G3A
B&R Code: EW3120074 Total Pages: 233

Key Words: TCR, best-basis inventory

Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-U-107 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

DATE:
STA: 4
HANFORD
RELEASE
ID:
AUG 2 8 1997

Christine L. McNeill 8/28/97

Release Approval Date

Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-614	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-U-107

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 9/18/96 on EDT 617551.	J. Jo	J. G. Kristofzski
0A RS	Incorporate per ECN-163506.	M. J. Kupfer	K. M. Hodgson
		M J Kupfer 8-27-97	K.M. Hodgson 8-27-97

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-U-107

This page intentionally left blank.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-U-107

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-U-107 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-U-107.

D1.0 CHEMICAL INFORMATION SOURCES

This Tank Characterization Report (TCR) for tank 241-U-107 (Section 4 and Appendix A) provides characterization results from the 1996 characterization event for this tank. Three core samples were obtained and analyzed. A sample-based inventory was prepared based on the core sample analytical results, measured waste densities, and a waste volume of 1,537 kL (406 kgal). The Hanford Defined Waste (HDW) model (Agnew et al. 1996) provides tank contents estimates, derived from process flowsheets and waste volume records.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The sample-based inventory estimate from Table 4.2, and the inventory estimate from the HDW model (Agnew et al. 1996) for tank 241-U-107 are shown in Table D2-1 and D2-2. The waste volume used to generate both estimates is 1,537 kL (406 kgal). The estimates, however, use different waste densities. The sample-based inventory used a measured bulk density of 1.52 g/mL for solids and 1.43 g/mL for supernatant. The current HDW model uses a higher waste density of 1.59 g/mL. Some significant differences between the sample-based and HDW model inventories are apparent, Al, Bi, Ca, F, Mn, Ni, NO_2, NO_3, OH, oxalate, Pb, PO_4, Si, SO_4, and U vary by a factor of two or more. (The chemical species are reported without charge designation per the best-basis inventory convention.)

Table D2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-U-107.

Analyte	Sampling inventory estimate[a] (kg)	HDW model inventory estimate (kg)	Analyte	Sampling inventory estimate[a] (kg)	HDW model inventory estimate (kg)
Al	19,100	140,000	Na	460,000	391,000
Ag	33.4	NR	Nd	<128	NR
As	<128	NR	Ni	59.8	501
B	200	NR	NO_2	65,500	148,000
Ba	<64.1	NR	NO_3	1,070,000	422,000
Be	<6.41	NR	oxalate	6,860	4.39
Bi	<149	368	Pb	<213	7,270
Ca	654	3,140	Sb	<80.7	NR
Ce	<128	NR	Se	<169	NR
Cd	<10.1	NR	Si	446	2,980
Cl	5,930	9,340	S as SO_4	10,400	30,000
Co	<25.7	NR	Sr	<13.8	1.7
Cr	5,270	3,850	TIC as CO_3	32,850	35,900
Cu	<18.3	NR	Th	<257	NR
F	<591	1,890	Ti	<14.0	NR
Fe	1,720	3,190	TOC	4,950	16,700
FeCN/CN	NR	0	U_{TOTAL}	<688	16,300
Hg	NR	238	V	<64.1	NR
K	2,140	2,790	Zn	65.0	NR
La	<66.3	8.09	Zr	<17.3	111
Mg	<175	NR	H_2O (wt%)	24.6	34.4
Mn	698	273	Density (kg/L)	solids 1.52 liquid 1.43	1.59
Mo	<76.5	NR			

HDW = Hanford Defined Waste, Agnew et al. (1996)
NR = Not reported
[a] Table 4-2.

Table D2-2. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-U-107.

Analyte	Sampling inventory estimate[a] (Ci)	HDW model inventory estimate[b] (Ci)	Analyte	Sampling inventory estimate[a] (Ci)	HDW model inventory estimate[b] (Ci)
^{60}Co	<41.6	NR	^{155}Eu	<573	NR
^{90}Sr	53.9	153,000	$^{239/240}Pu$	0.00590	0.0048
^{137}Cs	206,000	319,000	^{241}Am	<1,360	NR
^{154}Eu	<155	NR	Total α	221	NR

HDW = Hanford Defined Waste
NR = Not reported.
[a] Table 4-2, radionuclides reported as of analysis date
[b] Agnew et al. (1996) radionuclides decayed to January 1, 1994.

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed in order to identify potential errors and/or missing information that would influence the sampling-based and HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Tank 241-U-107 was put into service in September of 1948 as the first tank in the 241-U-107, 241-U-108, and 241-U-109 cascade. The cascade received metal waste from T Plant. Waste began overflowing from tank 241-U-107 in December 1948 and tank 241-U-108 overflowed to tank 241-U-109 in March 1949. Metal waste was removed by sluicing in 1953 to 1954 and the metal waste cascade from T Plant was restarted in June 1954. Tank 241-U-107 was sluiced in 1956 and declared empty in March 1957 (Anderson 1990, Rodenhizer 1987).

The tank received Reduction and Oxidation (REDOX) cladding waste (CW) supernatant in 1957 and 1958 from tank 241-S-107. Miscellaneous supernatants including REDOX CW supernatant were received in 1959. In 1969 tank 241-U-107 received supernatant from 241-SX-105 and 241-S-107 as bottoms form the REDOX evaporator. From 1969 to 1980, tank 241-U-107 was used to receive supernatant from various tanks, N Reactor waste, 300 Area laboratory waste, T Plant Decontamination waste, and 222S Laboratory waste.

The 100 Area and 300 Area wastes were introduced through the 204-S facility. Waste was also transferred out of tank 241-U-107 during this time.

Between 1976 and 1980 tank 241-U-107 received supernatant from tanks 241-S-102 and 241-SY-102 as evaporator bottoms (EB) from the 242-S Evaporator.

The current waste volumes for tank 241-U-107 are shown in Table D3-1 (Hanlon 1996).

Table D3-1. Waste Inventory of Tank 241-U-107 (Hanlon 1996).

Waste	Volume (kL)	Volume (kgal)
Sludge	57	15
Salt cake	1,363	360
Supernatant	117	31
Drainable Liquid	556	147
Total Waste	1,537	406

Table D3-2 summarizes the documented quantities of waste discharged to tank 241-U-107 from the HDW model waste transaction database (WSTRS) (Agnew et al. 1995). Table entries with negative values are for transfers out of the tank. Quantities cascaded to other tanks or removed by self concentration have not been included. These records indicate that the solids in this tank should be mostly salts from concentration of dilute wastes.

Table D3-2. Waste Transaction Information for Tank 241-U-107. (3 Sheets)

Waste source	Waste volume (kL)[a]	Waste volume (kgal)
$BiPO_4$ Metal Waste	6,019	1,590
Flush Water	693	183
Tank sluiced to UR	-2,006	-530
$BiPO_4$ Metal Waste	6,000	1,583
Flush Water	1,957	517
Tank sluiced to UR	-2,006	-530
REDOX CW supernatant	3,282	867
Moved to 241-U-108	-2,839	-750

Table D3-2. Waste Transaction Information for Tank 241-U-107. (3 Sheets)

Waste source	Waste volume (kL)[a]	Waste volume (kgal)
REDOX Evaporator Bottoms from 241-SX-105	2,835	749
REDOX Evaporator Bottoms from 241-S-107	1,071	283
Flush Water	220	58
Moved to 241-U-108, 241-U-109	-2,710	-716
241-T-112 supernatant	3,290	869
Moved to 241-TX-101, 241-U-108, 241-C-104	-2,642	-698
N Reactor waste	3,502	925
PNL laboratory waste	2,517	665
241-T-103, 241-S-106, 241-S-107 supernatant	1,745	461
Moved to 241-C-104, 241-S-101	-5,583	-1,475
241-U-110 supernatant	1,261	333
T Plant decontamination waste	1,809	478
Flush water	140	37
N Reactor waste	4,607	1,217
PNL laboratory waste	2,956	781
Moved to 241-S-101, 241-S-110, 241-S-107	-6,972	-1,842
Laboratory Waste	201	53
Waste and Flush Water	393	104
Moved to 241-S-107	-984	-260
T Plant decontamination waste	2,161	571
222S laboratory waste	386	102
Moved to U-108	-5,617	-1,484
N Reactor waste	57	15
PNL laboratory waste	810	214
Waste water	34	9
Moved to 241-U-108, 241-U-103	-1,953	-516

Table D3-2. Waste Transaction Information for Tank 241-U-107. (3 Sheets)

Waste source	Waste volume (kL)[a]	Waste volume (kgal)
241-S-102 Evaporator Feed	1,408	372
241-SY-102 Supernatant via 242-S Evaporator	3,838	1,014
Moved to 241-S-102, 241-SY-112, 241-U-111	-4,769	-1,260
Caustic additions	132	35
241-SY-102 Supernatant via 242-S Evaporator	11,350	2,993
Moved to 241-SX-106, 241-U-111, 241-SY-102	-11,238	-2,969
241-SY-102 Supernatant via 242-S Evaporator	257	68
Total Waste Added	64,900	17,146
Total Waste Removed	-49,320	-13,030
Current Inventory	1,537	406

PNL = Pacific Northwest Laboratory
REDOX CW = Cladding waste from REDOX process
[a] Agnew et al. (1995).

The types of solids accumulated in tank 241-U-107 reported by various authors is compiled in Table D3-3 and Table D3-4.

Table D3-3. Expected Solids for Tank 241-U-107.

Reference	Waste type
Anderson (1990)	CW, CW-EB, DW-BNW, LW, N, NCPLX, CPLX, DSSF
SORWT Model (Hill et al. 1995)	EB, CW, MIX
WSTRS (Agnew et al. 1995)	SU, CW, N, BNW, DW, LW, EVAP
HDW Model (Agnew et al. 1996)	CWR1, SMMT2, SMMS2

BNW = Battelle Northwest Laboratory waste
CPLX = Complexed waste
CW = Cladding waste
CWR1 = REDOX cladding waste from 1952 to 1960
DSSF = Double-shell slurry feed
DW = Decontamination waste
EB = Evaporator bottoms
EVAP = Evaporator feed
HDW = Hanford Defined Waste
LW = Laboratory waste
MIX = Mixture of several miscellaneous wastes
N = N Reactor waste
NCPLX = Non-Complexed Waste
REDOX = Reduction and Oxidation
SMMS2 = Supernatant Mixing Model 242-S Evaporator salt cake generated from 1977 until 1980
SMMT2 = Supernatant Mixing Model 242-T Evaporator salt cake generated from 1965 until 1976
SORWT = Sort on Radioactive Waste Type.
SU = Supernatant
WSTRS = Waste Status and Transaction Record Summary.

Table D3-4. Hanford Defined Waste Model Solids for Tank 241-U-107[a].

Tank Layer Model solids layer	kL	kgal
CWR1	288	76
SMMT2	53	14
SMMS2	1,079	285

CWR1 = REDOX cladding waste from 1952 to 1960
REDOX = Reduction and Oxidation
SMMS2 = Supernatant Mixing Model 242-S Evaporator salt cake generated from 1977 until 1980
SMMT2 = Supernatant Mixing Model 242-T Evaporator salt cake generated from 1965 until 1976
[a] Agnew et al. (1996).

D3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

Core sample recovery was poor for tank 241-U-107. Although each core was planned to have eight segments per core, hard waste limited the core samples to 2, 3 and 6 segments. Thus even the most complete core sample did not include the lower 396 kL (104.6 kgal) (15 cm [38 in.]) of waste. Overall recovery of individual segments were low. Section 5.3 also reports significant color variations in the individual half segments of core. This color variation could imply that the vertical homogeneity of the waste is poor.

A discrepancy also exists between the Hanlon report and the HDW model with respect to layering in the tank. Hanlon reports 57 kL (15 kgal) of sludge in the bottom of the tank, whereas the HDW model indicates that 288 kL (76 kgal) of solids from REDOX CW being in the bottom of the tank. Review of Anderson (1990) and Agnew et al. (1995) indicate the following chain of events probably occurred:

- All accumulated metal waste was removed from the tank by sluicing and the tank was declared empty in 1957.
- 288 kL (76 kgal) of solids from REDOX CW supernatant were accumulated in the tank by the end of 1968.
- 53 kL (14 kgal) of solids were added to the tank as REDOX evaporator bottoms in 1969 for a total of 341 kL (90 kgal) of solids. The REDOX evaporator bottoms came from REDOX high-level waste (HLW) supernatants removed from tanks 241-S-107 and 241-SX-105.
- Use of the tank to collect and stage large volumes of dilute wastes (1972 to 1974) resulted in the solids inventory being reduced to 57 kL (15 kgal).

- The tank was used to collect and stage additional dilute wastes (1975 to 1976). The impact on the solids inventory was not measured.

- 242-S Evaporator-crystallizer bottoms were added to the tank bringing the solids inventory to 598 kL (158 kgal) (1977 to 1978).

- Various supernatants from 241-SY-102 were received and sent from tank 241-U-107 during 1979 and 1980. The impact on solids volume was not measured during this time. Since tank 241-SY-102 was designated at the 242-S Evaporator feed tank, it is probable that transfers to tank 241-U-107 were through the 242-S Evaporator and that additional solids did accumulate. The tank may have also received dilute wastes through the 204-S facility during this time.

- The solids volume measured at the end of 1980 was 1,419 kL (375 kgal) and the total waste volume was 1,537 kL (406 kgal).

From these observations it is concluded that the bottom layer in tank 241-U-107 is a modified REDOX CW. The REDOX CW added to the tank was REDOX CW supernatant rather than REDOX CW received from directly from the REDOX Plant, as is assumed by the HDW model. The REDOX CW laid down in tank 241-U-107 was then heavily leached by dilute wastes routed through the tank.

Therefore the actual quantities of CWR1 and SMMT2 are much smaller than the volumes assumed by the HDW model. Tank 241-U-107 contains no more than 57 kL (15 kgal) of CWR1 and SMMT2 solids, a loss of 83 percent of these layers. These solids may not have been dissolved uniformly by the dilute wastes routed through the tank and may exhibit a different composition than is calculated by the HDW model.

To compensate for the smaller CWR1 and SMMT2 layer, modeling of the SMMS2 layer should be increased from 1,079 kL (285 kgal) to 1,363 kL (360 kgal). The overall volume of waste in the tank remains constant by this change.

The sample data from the 1996 sampling event (Section 4.0 and Appendix A) are assumed to be representative of the SMMS2 layer and supernate in tank 241-U-107. Table D3-5 compiles an estimate of the SMMS2 inventory based on 117 kL (31 kgal) of supernatant and 1,363 kL (360 kgal) of salt cake with density of 1.52 g/mL.

Table D3-5. SMMS2 and Supernatant Inventory in Tank 241-U-107.

Analyte	Mean liquid concentration[a] (μg/mL)	Liquid inventory (kg)	Mean solid concentration[a] (μg/g)	SMMS2 solid inventory (kg)
Al	23,100	2,700	7,620	15,800
Bi	<73.4	<8.59	<64.9	<134
Ca	95.9	11.2	298	617
Cl	7,900	924	2,320	4,810
TIC as CO_3	26,980	3,160	13,740	28,500
Cr	567	66.3	2,410	4,990
Fe	<35.1	<4.11	799	1,655
K	3,150	369	819	1,700
La	<36.7	<4.29	<27.7	<57.4
Mn	<7.34	<0.859	323	669
Na	219,000	25,600	201,000	416,000
Ni	17.4	2.04	26.8	55.5
NO_3	238,000	27,800	481,000	997,000
NO_2	96,200	11,300	25,100	52,000
Pb	<73.4	<8.59	<94.4	196
P as PO_4	3,830	448	12,300	25,500
Si	164	19.2	198	410
S as SO_4	6,390	748	4,490	9,300
Sr	<7.34	<0.859	<5.96	<12.4
TOC	4,070	476	2,070	4,300
U_{TOTAL}	<367	<42.9	<299	<619
Zr	<7.34	<0.859	<7.61	<15.8

SMMS2 = Supernatant Mixing Model 242-S Evaporator salt cake generated from 1977 until 1980

[a]Table 4-2.

Of the alternatives available for establishing the composition of the REDOX CW layer in tank 241-U-107, the preferred method is to use sample data of REDOX CW from another tank.

Tank 241-U-204 contains 7.6 kL (2 kgal) of REDOX CW that was transferred from another tank and then heavily leached with dilute waste. This process history is very similar to processes that formed the REDOX CW layer in tank 241-U-107. The ratio of original to final solids volume of REDOX CW, before and after leaching, in tank 241-U-204 is similar to the ratio of original to final solids volume of REDOX CW in tank 241-U-107, 6.0 and 5.1 respectively. Table D3-6 provides an estimate of REDOX CW solids in tank 241-U-107 from sample data extracted from the TCR for tank 241-U-204 (Raphael and Tran 1995). The calculated inventory assumes 57 kL (15 kgal) of REDOX CW solids with a density of 1.76 g/mL.

Table D3-6. Estimated Inventory for Solids Fraction of REDOX Cladding Waste Layer of Tank 241-U-107 Derived from Tank 241-U-204. (2 Sheets)

Analyte	Tank[a] 241-U-204 1978 sample (µg/g)	Tank 241-U-204 1995 sample[a]				Mean concentration 241-U-204 sample (µg/g)	241-U-107 REDOX CW layer estimate[b] (kg)
		Core 81 sample (µg/g)	Core 81 duplicate (µg/g)	Core 82 sample (µg/g)	Core 82 duplicate (µg/g)		
Al	NR	186,838.00	185,674.69	252,265.17	258,522.03	220,824.97	19,100
Bi	NR	2292.93	1763.89	389.07	374.63	1,205.34	104
Ca	NR	1887.32	1696.24	188.13	<157.46	982.29	85.1
Cl	100	NR	NR	NR	NR	100	8.7
Cr	NR	226.18	225.93	124.37	126.05	175.63	15.2
F	4,000	NR	NR	NR	NR	4,000	347
Fe	NR	4332.36	2676.33	1,944.92	1,936.30	2,722.48	236
K	NR	NR	NR	NR	NR	NR[b]	NR[b]
La	NR	<78.39	<78.39	<78.73	<78.73	<78.56	<6.8
Mn	NR	132.38	107.43	46.67	42.16	82.16	7.1
Na	NR	21,595.62	21,932.12	14,430.18	14,691.09	18,162.25	1,570
Ni	NR	4,646.80	4,881.33	3,286.36	2,934.13	3,937.16	NR[c]
NO_2	3,000	NR	NR	NR	NR	3,000	260
NO_3	12,000	NR	NR	NR	NR	12,000	1,040
Pb	NR	12,430.93	10,793.78	3,020.24	3,055.06	7,325.00	635
P as PO_4	NR	3,419.47	3,287.99	<965.03	<965.03	2,159.38	187
Si	NR	4,082.16	3,808.76	952.49	699.29	2,385.68	207
S as SO_4	NR	<469.70	<469.70	<471.74	<471.74	<470.72	<41
Sr	NR	54.69	49.21	<15.75	<15.75	<33.85	<3
TOC	470	NR	NR	NR	NR	470	41

Table D3-6. Estimated Inventory for Solids Fraction of REDOX Cladding Waste Layer of Tank 241-U-107 Derived from Tank 241-U-204. (2 Sheets)

Analyte	Tank[a] 241-U-204 1978 sample (μg/g)	Tank 241-U-204 1995 sample[c]				Mean concentration 241-U-204 sample (μg/g)	241-U-107 REDOX CW layer estimate[b] (kg)
		Core 81 sample (μg/g)	Core 81 duplicate (μg/g)	Core 82 sample (μg/g)	Core 82 duplicate (μg/g)		
U_{TOTAL}	NR	1,969.41	2,103.72	<787.31	<787.31	<1,411.94	<122
Zr	Nr	<15.68	<15.68	54.49	19.67	<26.38	<2.3

NR = Not reported
REDOX = Reduction and Oxidation
[a] Raphael and Tran 1995
[b] The sample was prepared by KOH fusion, thus the inductively coupled plasma spectroscopy (ICP) values for K were not reliable.
[c] Nickel crucibles used to fuse the sample are assumed to have contaminated the sample with nickel.

Table D3-7 provides an estimate of the liquid fraction of the REDOX CW layer in tank 241-U-107 from sample data extracted from the TCR for tank 241-U-204 (Raphael and Tran 1995). The liquid retained in the REDOX CW layer is expected to be a dilute waste. The SpG for liquid waste from tank 241-U-204 is 1.064 and is applied to this fraction. The quantity of liquid waste is calculated from the 57 kL (15 kgal) REDOX CW layer by assuming the water content and density of the SMMS2 layer, 22.7 wt% water and 1.52 g/mL respectively.

Table D3-7. Estimated Inventory for Liquid Fraction of REDOX Cladding Waste Layer of Tank 241-U-107 Derived from Tank 241-U-204. (2 Sheets)

Analyte	Tank 241-U-204 1995 sample[a]				Mean concentration (μg/g)	Estimated inventory[c] (kg)
	Core 81 sample (μg/g)	Core 81 duplicate (μg/g)	Core 82 sample (μg/g)	Core 82 duplicate (μg/g)		
Al	650	634	617	599	625	12.2
Bi	<20.1	<20.1	<20.1	<20.1	<20.1	<0.4
Ca	<20.1	<20.1	<20.1	<20.1	<20.1	<0.4
Cl	Included in Table D3-6[b]				NR	NR
TIC as CO_3	Included in Table D3-6[b]				NR	NR
Cr	393	385	395	389	391	7.7

Table D3-7. Estimated Inventory for Liquid Fraction of REDOX Cladding Waste Layer of Tank 241-U-107 Derived from Tank 241-U-204. (2 Sheets)

Analyte	Tank 241-U-204 1995 sample[a]				Mean concentration (μg/g)	Estimated inventory[c] (kg)
	Core 81 sample (μg/g)	Core 81 duplicate (μg/g)	Core 82 sample (μg/g)	Core 82 duplicate (μg/g)		
F	Included in Table D3-6[b]				NR	NR
Fe	18.3	15.3	24.3	16.0	18.5	0.36
K	217	208	225	230	220	4.3
La	<20.1	<20.1	<20.1	<20.1	<20.1	<0.4
Mn	<20.1	<20.1	<20.1	<20.1	<20.1	<0.4
Na	36,,000	35,700	37,500	37,200	36,600	717
Ni	<4.02	<4.02	<4.02	<4.02	<4.02	<0.08
NO_2	Included in Table D3-6[b]				NR	NR
NO_3	Included in Table D3-6[b]				NR	NR
Pb	33.6	31.0	46.5	53.2	41.1	0.8
P as PO_4	2,333	2,300	2,536	2,477	2,412	47.2
SI	50.3	44.0	55.8	58.9	52.3	1.02
S as SO_4	503	491	533	518	511	10.0
Sr	<20.1	<20.1	<20.1	<20.1	<20.1	<0.4
TOC	Included in Table D3-6[a]				NR	NR
U_{TOTAL}	<101	<101	<101	<101	<101	1.98
Zr	<20.1	<20.1	<20.1	<20.1	<20.1	<0.4

[a] Raphael and Tran (1995)

[b] The sample used for these analytes included was not split into solid and liquid fractions

[c] Based on 57 kL (15 kgal), 1.52 g/mL, and 22.7 wt% water.

Table D3-8 presents the summed results of Table D3-6 and Table D3-7.

Table D3-8. Composition of the REDOX Cladding Waste Layer Derived From the Tank 241-U-204 Sample Data.

Analyte	Solid fraction of REDOX CW layer derived from tank 241-U-204 sample data (see Table D3-6) (kg)	Liquid fraction of REDOX CW layer derived from tank 241-U-204 sample data (see Table D3-7) (kg)	Estimated inventory of REDOX CW layer in tank 241-U-107 (kg)
Al	19,100	12.2	19,100
Bi	104	<0.4	104
Ca	85.1	<0.4	85.1
Cl	8.7	NR	8.7
Cr	15.2	7.7	22.9
F	347	NR	347
Fe	236	0.36	236
K	NR	4.3	NR
La	<6.8	<0.4	<7.2
Mn	7.1	<0.4	7.1
Na	1,570	717	2,287
Ni	NR	<4.02	NR
NO_3	1,040	NR	1,040
NO_2	260	NR	260
Pb	635	0.8	636
P as PO_4	187	47.2	234
Si	207	1.02	208
S as SO_4	<41	10.0	<51
Sr	<3	<0.4	<3.4
TOC	41	NR	41
U_{TOTAL}	<122	1.98	<124
Zr	<2.3	<0.4	<2.7

CW = Cladding waste
NR = Not reported
REDOX = Reduction and Oxidation.

Table D3-9 compiles the engineering basis estimate of tank 241-U-107 using the REDOX CW waste estimate derived from tank 241-U-204 shown in Table D3-8 and the sample-based SMMS2 layer estimate and supernatant layer estimate shown in Table D3-5. Once the total inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997).

Table D3-9. Engineering Estimate of Tank 241-U-107 Inventory. (2 Sheets)

Analyte	REDOX CW inventory (kg)	SMMS2 inventory (kg)	Supernatant inventory (kg)	Total inventory (kg)
Al	19,100	15,800	2,700	37,600
Bi	104	<134	<8.59	<247
Ca	85.1	617	11.2	738
Cl	8.7	4,810	924	5,740
TIC as CO_3	NR	28,500	3,160	31,700
Cr	22.9	4,990	66.3	5,080
F	347	<542	<26.8	<916
Fe	236	1,655	<4.11	1,900
K	NR	1,700	369	2,070
La	<7.2	<57.4	<4.29	<69
Mn	7.1	669	<0.859	677
Na	2,287	416,000	25,600	444,000
Ni	NR	55.5	2.04	57.5
NO_3	1,040	997,000	27,800	1.03 E+06
NO_2	260	52,000	11,300	63,600
Pb	636	196	<8.59	841
P as PO_4	234	25,500	448	26,200
Si	208	410	19.2	637
S as SO_4	<51	9,300	748	10,100
Sr	<3.4	<12.4	<0.859	<16

Table D3-9. Engineering Estimate of Tank 241-U-107 Inventory. (2 Sheets)

Analyte	REDOX CW inventory (kg)	SMMS2 inventory (kg)	Supernatant inventory (kg)	Total inventory (kg)
TOC	41	4,300	476	4,820
U_{TOTAL}	<124	<619	<4.29	<747
Zr	<2.7	<15.8	<0.859	<19.4

CW = Cladding Waste
NR = Not reported
REDOX = Reduction and Oxidation
SMMT2 = Supernatant Mixing Model from 242-T Evaporator salt cake generated from 1965 until 1976.

Table D3-10 compares the TCR sample-based estimate, the HDW model estimate and the engineering estimate for the Tank 241-U-107 Inventory.

Table D3-10. Comparison of the Sample-Based Estimate, the Hanford Defined Waste Model Estimate, and the Engineering Estimate for the Tank 241-U-107 Inventory. (2 Sheets)

Analyte	TCR sample-based inventory estimate (kg)	HDW model inventory estimate (kg)	Engineering inventory estimate (kg)
Al	19,100	140,000	37,600
Bi	<149	368	<247
Ca	654	3,140	738
Cl	5,930	9,340	5,740
TIC as CO_3	32,850	35,900	31,700
Cr	5,270	3,850	5,080
F	<591	1,890	<916
Fe	1,720	3,190	1,900
Hg	NR	238	NR
K	2,140	2,790	2,070
La	<66.3	8.09	<69
Mn	698	273	677

Table D3-10. Comparison of the Sample-Based Estimate, the Hanford Defined Waste Model Estimate, and the Engineering Estimate for the Tank 241-U-107 Inventory. (2 Sheets)

Analyte	TCR sample-based inventory estimate (kg)	HDW model inventory estimate (kg)	Engineering inventory estimate (kg)
Na	460,000	391,000	444,000
Ni	59.8	501	57.5
NO_3	1.07 E+06	422,000	1.03 E+06
NO_2	65,600	148,000	63,600
Pb	<213	7,270	841
P as PO_4	26,900	11,200	26,200
Si	446	2,980	637
S as SO_4	10,400	30,000	10,100
Sr	<13.8	1.7	<16
TOC	4,950	NR	4,820
U_{TOTAL}	<688	16,300	<747
Zr	<17.3	111	<19.4

HDW = Hanford Defined Waste, Agnew et al. (1996)
NR = Not reported
TCR = Tank Characterization Report.

The engineering evaluation estimate corrects the sample-based estimate for waste layers in tank 241-U-107 that were not accessed during sampling. These layers were identified through tank farm process records.

Photos of tank interior show a liquid surface with a dispersed solids material floating on the surface. The photo is current relative to the inventory shown in Table D3-10.

D3.3 DOCUMENT ELEMENT BASIS

The differences between the engineering-based evaluation and the HDW model are essentially the same as the differences between the sample-based inventory and the HDW model. However the corrections to the sample-based inventory by the engineering evaluation trend toward the HDW model estimate. The engineering evaluation inventory used a measured bulk density of 1.52 g/mL. The current HDW model uses a higher waste density of 1.59 g/mL.

Aluminum. The sample-based estimate, HDW model, and engineering evaluation for aluminum are 19,100 kg, 140,000 kg and 60,600 kg respectively. The high aluminum estimates of the HDW model may be biased by the overall Al inventory assumed in the HDW model and the low Al solubility assumed for REDOX CW.

Bismuth. The sample-based estimate, HDW model, and engineering evaluation for bismuth are <149 kg, 368 kg and <247 kg respectively. The source of bismuth in the HDW model would appear to be due the assumptions inherent to the SMMS2 model.

Calcium. The sample-based estimate, HDW model, and engineering evaluation for calcium are 654 kg, 3,140 kg and 738 kg respectively. The source of calcium in the HDW model would appear to be due the assumptions inherent to the SMMS2 model.

Iron. The sample-based estimate, HDW model, and engineering evaluation for iron are 1,720 kg, 3,190 kg and 1,900 kg respectively. The high iron inventory for the HDW model appears to have been introduced by the MW and CWR1 layers assumed by the model to be present in the tank. The process review conducted by the engineering evaluation indicates that the HDW model should not include a MW layer and that the CWR1 layer should be introduced as CWR1 supernatant rather than CWR1 waste. These two changes would reduce the iron value in the HDW model for this tank.

Manganese. The sample-based estimate, HDW model, and engineering evaluation for manganese are 698 kg, 273 kg and 677 kg respectively. The source of manganese found in the sample-based inventory has not been identified, but could be T Plant decontamination waste that included $KMnO_4$.

Silicon. The sample-based estimate, HDW model, and independent evaluation for silicon are 446 kg, 2,980 kg and 637 kg respectively. The HDW model indicates that 2,820 kg of silicon is introduced to tank 241-U-107 in the SMMS2 model. The assumptions in these models have not been examined.

Sulfate. The sample-based estimate, HDW model, and independent evaluation for sulfate are 10,400 kg, 30,000 kg and 10,100 kg respectively. The HDW model indicates that 29,800 kg of sulfate are introduced to tank 241-U-107 in the SMMS2 model. This number, is substantially larger than the sample-based inventory.

Phosphate. The sample-based estimate, HDW model, and independent evaluation for phosphate are 26,900 kg, 11,200 kg and 26,200 kg respectively. Comparison of these three values suggests that the tank contains more phosphate bearing salt cake than was identified in the transaction records. A possible source could be phosphate based decontamination agents from T Plant and other facilities.

Total Inorganic Carbon. The sample-based estimate, HDW model, and independent evaluation for total inorganic carbon are 32,850 kg, 35,900 kg and 31,700 kg respectively. These values are essentially the same.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997).

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-A-102 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

The results from this evaluation support using the engineering evaluation as the best-basis for Tank 241-U-107 for the following reasons.

1. Although core samples were obtained from three risers, recovery was poor. Of the eight planned segments for each riser only 2, 3, and 6 segments were recovered. This left the bottom 396 kL (105 kgal) (38 in.) waste unsampled. Thus the Table 4-2 extrapolation of the sample-based estimate to the full tank is inaccurate.

2. The HDW model incorrectly includes an bismuth phosphate MW layer that process records show to have been removed from the tank.

3. The HDW model incorrectly introduces CWR1 waste to the tank rather than supernatant from a CWR1 tank. The HDW model does not appear to model the leaching effect of dilute waste on the CWR1 layer.

4. The multitude of waste types that are the tank or were added to the tank and later removed has resulted in a tank history that is sufficiently complex that reliable comparison to process flowsheets is impractical.

Best-basis inventory estimates for tank 241-U-107 are presented in Tables D4-1 and D4-2. The projected inventory is based on an engineering evaluation of the tank. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis tables for chemicals and only four radionuclides (^{90}Sr, ^{137}Cs, Pu, and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the HDW model. When values for all 46 radionuclides became available in Rev. 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-U-107 (Effective January 31, 1997).

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	37,600	E	
Bi	<247	E	
Ca	738	E	
Cl	5,740	E	
TIC as CO_3	31,700	E	
Cr	5,080	E	
F	<916	E	
Fe	1,900	E	
Hg	238	M	
K	2,070	E	
La	<69	E	
Mn	677	E	
Na	444,000	E	
Ni	57.5	E	
NO_2	63,600	E	
NO_3	1.03 E+06	E	
OH_{TOTAL}	61,000	C	Based on charge balances
P as PO_4	26,200	E	
Pb	841	E	
S as SO_4	10,100	E	
Si	637	E	
Sr	<16	E	
TOC	4,820	E	
U_{TOTAL}	<747	E	
Zr	<19.4	E	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1996)
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-107 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	335	M	
^{14}C	48.3	M	
^{59}Ni	3.13	M	
^{60}Co	<41.6	S	
^{63}Ni	307	M	
^{79}Se	4.8	M	
^{90}Sr	57.2	S	
^{90}Y	57.2	S	In equilibrium with ^{90}Sr
^{93m}Nb	17.1	M	
^{93}Zr	23.6	M	
^{99}Tc	344	M	
^{106}Ru	0.00952	M	
^{113m}Cd	124	M	
^{125}Sb	230	M	
^{126}Sn	7.25	M	
^{129}I	0.664	M	
^{134}Cs	3.65	M	
^{137m}Ba	206,000	S	In equilibrium with ^{137}Cs
^{137}Cs	218,000	S	
^{151}Sm	16,900	M	
^{152}Eu	5.6	M	
^{154}Eu	<190	S	
^{155}Eu	<815	S	
^{226}Ra	2.06 E-04	M	
^{227}Ac	0.0013	M	
^{228}Ra	0.201	M	
^{229}Th	0.00472	M	
^{231}Pa	0.00596	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-107 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}Th	0.0134	M	
^{232}U	1.03	M	
^{233}U	3.96	M	
^{234}U	5.41	M	
^{235}U	0.228	M	
^{236}U	0.13	M	
^{237}Np	1.26	M	
^{238}Pu	9.18	M	
^{238}U	5.49	M	
$^{239/240}Pu$	0.0059	S	
^{241}Am	<1,360	S	
^{241}Pu	531	M	
^{242}Cm	0.211	M	
^{242}Pu	0.00242	M	
^{243}Am	0.00283	M	
^{243}Cm	0.0195	M	
^{244}Cm	0.192	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997)
E = Engineering assessment-based.

This page intentionally left blank.

D5.0 APPENDIX D REFERENCES

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1995, *Waste Status and Transaction Record Summary (WSTRS Rev. 2)*, WHC-SD-WM-TI-615, -614, -669, -689, Rev. 2, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending May 31, 1996*, WHC-EP-182-99, Westinghouse Hanford Company, Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^{2}S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Raphael, G. F., and T. T. Tran, 1995, *Tank Characterization Report for Single-Shell Tank 241-U-204*, WHC-SD-WM-ER-486, Rev. 0-B, Westinghouse Hanford Company, Richland, Washington.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History,* WHC-SD-WM-TI-302, Westinghouse Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.